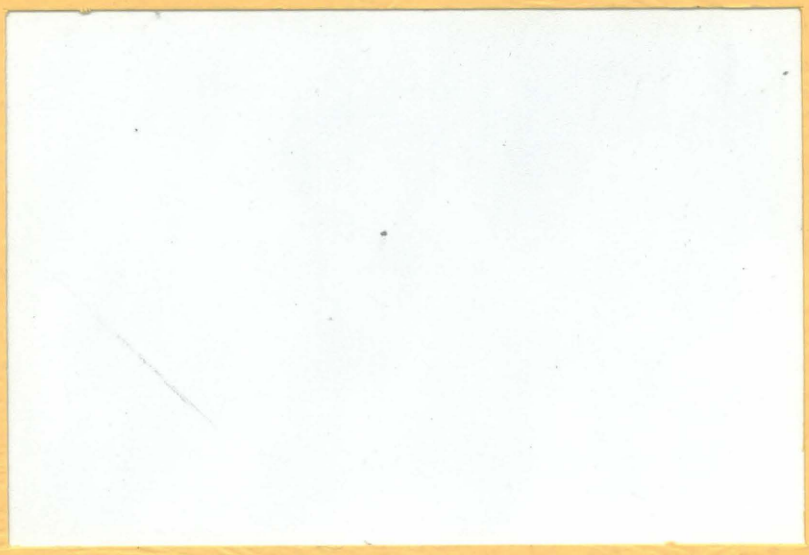
STUDIES IN RURAL FINANCE



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CREDIT-RATIONING BEHAVIOR OF AGRICULTURAL LENDERS: THE IRON LAW OF INTEREST-RATE RESTRICTIONS

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CREDIT-RATIONING BEHAVIOR OF AGRICULTURAL LENDERS: THE IRON LAW OF INTEREST-RATE RESTRICTIONS

Claudio Gonzalez-Vega

During the past three decades, formal financial institutions (FFIs) in low-income countries (LICs) have channeled large amounts of credit to agriculture. At the same time, through legal and financial controls, governments have kept at low levels the rates of interest that FFIs can charge on loans. The preferential rates charged for loans in agriculture and, in particular, those for small farmers have been especially low. Recent financial reforms in some LICs, although increasing most rates, often have not raised the preferential rates for agriculture. As a result, interest rate differentials between agriculture and nonagriculture have increased. These differentials have not reflected the costs and risks of FFIs lending to different borrower classes. Rather, they have reflected the political intent to favor some groups at the expense of others.

Often the preferential rates have been mandated with the best of intentions. They may have been adopted to promote socially desirable activities or to benefit marginal groups. Unfortunately, such preferential-rate policies have frequently resulted in consequences opposite of those desired and have repressed savings mobilization and formal financial intermediation in general, thus causing lower rates of economic growth. By reducing the size of domestic

formal financial markets, these policies have had the effect of increasing the importance of foreign debt as a means of financing capital formation and of augmenting the dependency of LICs. By distorting the allocative functions of interest rates, these policies have prevented savings from being channeled to their most socially profitable uses.

FFIs take into account the costs and risks associated with lending to different borrower classes. If forced to charge differential interest rates, they adopt predictable rationing mechanisms that have a considerable impact on the final allocation of credit. In the discussion that follows, I explore the determinants of the behavior of borrowers and lenders under interest-rate restrictions. I examine the consequences of such controls on the final composition of loan portfolios, and argue that the behavior of borrowers and lenders leads to a redistribution of loan portfolios to a relatively small number of large borrowers as well as to the exclusion from these portfolios of large numbers of small potential borrowers.

Impact of Interest-Rate Ceilings

The traditional analysis of the impact of interest-rate ceilings posits a market for credit that is characterized by an aggregate demand for loans inversely related to the loan rate of interest and an aggregate supply of deposits that is directly related to the deposit rate of interest. In this

model, the imposition of a ceiling on the loan rate leads to a decline in the rate paid to depositors. As a result, fewer resources are mobilized, and the total volume of lending declines. Further, at the ceiling loan rate there is an excess demand for credit and nonprice rationing mechanisms are required to clear the market. The demands by all or some of the potential borrowers will be totally or partially frustrated.

It is increasingly recognized that these rationing processes have an unfavorable impact on small farmers, as a result of the high risks and costs associated with lending to small borrowers. The conventional analysis, however, does not explain how these rationing processes clear the market. In particular, although the conventional model shows that depositors are worse off as a consequence of the ceiling, it does not show if all borrowers (as a group) or specific borrower classes are better off. Since it does not explain how the new, smaller amounts of credit are allocated among borrower classes, this model cannot predict if the reduction in the loan rate is less or more than compensated for by a decline in the size of the loans received. Thus, the conventional analysis sheds little light on the impact of interest-rate ceilings on the allocation of resources and on the distribution of income.

The imposition of a binding ceiling on interest rates has at least three aggregate and distributive effects on the

portfolios of FFIs. First, a reduction in the size of the total portfolio of assets will occur, because a drop in the rate paid on deposits reduces the ability of FFIs to attract savings. The reduction in the rate of profit caused by the ceiling also reduces the ability to attract equity capital and to borrow. Second, since ceilings on the loan rates of interest reduce the relative profitability of lending, the proportion of the total asset portfolio of the FFIs devoted to loans will decline. Third, a change in the composition of the loan portfolio of the FFIs will take place. Loan-rate ceilings alter the relative profitability of loans to different borrower classes. Depending on the rationing mechanisms adopted, the ceilings lead to changes in the relative shares of the loan portfolios going to different borrowers. These redistributions usually lead to greater portfolio concentration.

Types of Rationing

Any loan has three aspects: the size, the interest rate charged, and the noninterest terms of the loan contract. For the reasons to be discussed, given the risks, transaction costs, and information costs associated with lending to different borrower classes, most FFIs try to optimize the adjustment of these three aspects of a loan to each particular borrower. When the ceilings on loan rates become binding, lenders are forced to adjust the non-interest terms of the loan contract or to reduce loan size.

The result is that borrowers receive a less attractive combination of these three aspects of their loans and the profits of the FFIs decline. The welfare of both rationed borrowers and of lenders could be improved by the elimination of the ceilings.

Of the three ways to clear a credit market (through interest rates, through changes in the noninterest terms of the loan contract, and through changes in loan size), the first two are examples of rationing-through-price, in contrast to rationing-through-quantities. (The noninterest terms of the loan contract may be considered as elements of the price vector of the loan, in addition to the rates charged.) The third way, however, is clearly a form of nonprice rationing. When the borrowers are rationed out of the market by imposition of less attractive noninterest terms on the loans, it is the borrower who decides that the price is too high. In the event of nonprice rationing, on the other hand, the potential borrower is willing to pay the full price (all elements in the price vector of the loan), but the FFIs are not willing to grant a loan of the size demanded. In this case, an unsatisfied excess demand for credit prevails at the ruling interest rate. In practice, when ceilings on loan rates are imposed, rationing will occur through changes in both the noninterest terms of the loan contract and the loan size. Both types of rationing lead to greater loan-portfolio concentration.

Nonprice Credit Rationing

Several models of lender behavior can be used to explain rationing decisions. Portfolio theory provides insights because of uncertainty and risk; the theory of the multiproduct firm is useful because transactions costs and product heterogeneity and differentiation are important. Also, it is possible to capture uncertainty and risk within the theory of the firm by incorporating an *ex ante* premium for risk in the cost functions of the FFIs.

The application of general theories about price controls and black markets to financial markets has been useful to explain the existence of nonprice credit rationing. The analysis of the determinants of interest rates in informal credit markets of LICs and the attempts to measure transaction costs, risks of default, and monopoly profits have also helped. Theories about nonprice credit rationing, however, have been associated mostly with the controversy over the availability doctrine. Actually, the theory of nonprice credit rationing was developed to show, despite Samuelson's 1952 statement to the contrary, that this type of rationing behavior is consistent with rational profit maximization, even in the absence of interest-rate restrictions. *A fortiori*, this behavior is even more likely in the presence of such restrictions.

Hodgman (1960) showed that, because of the existence of default risk, any borrower will reach a loan size beyond

which he or she will not be able to obtain additional funds by promising to pay a higher interest rate. The supply of credit to an individual borrower becomes totally inelastic because each borrower's wealth and ability to repay are finite. To demonstrate the existence of nonprice rationing, however, it must be shown that an excess demand for credit persists at the rate charged in equilibrium. This requires a discussion both of supply and demand. That is, nonprice rationing occurs when the lender is unwilling to grant the loan demanded by the borrower and offers only a smaller amount. Jaffee (1971) set up a model of a lender who maximizes expected profits, taking into account possible borrower default. He formulated the lender's expected income from each loan as an explicit function of the parameters of the borrower's demand function, the probability of default, and the rate of interest charged on the loan. Within this framework, the proof of the rationality of rationing amounted to showing that the FFI can increase its expected profits by rationing some clients.

Jaffee showed that credit rationing is not profitable for a lender acting as a discriminating monopolist (one who maximizes expected profits with respect to each borrower separately and is free to charge each borrower a different interest rate). Rationing is profitable only if there are restrictions on interest-rate discrimination. That is, limited interest-rate differentiation, in the sense that

FFIs have to charge identical rates to nonidentical borrowers, makes it profitable for the FFIs to supply some borrowers with less than the amount of credit they demand at the going rate. Similar behavior will occur when an inverted interest-rate structure is enforced.

Aside from usury ceilings, other legal and moral restrictions and considerations of good will make it difficult to charge widely different interest rates to different borrowers. Instead, FFIs usually justify interest-rate differentials in terms of a few objective criteria, such as industry class. A classification scheme of this type is likely to result in a tacit collusive oligopolistic agreement among FFIs. The structure of interest rates is then compressed within narrower limits and nonprice rationing occurs. Constraints on rate differentiation may also result from the information costs associated with distinguishing among different borrowers and their risk characteristics (screening costs).

Keeton (1979) showed that nonprice rationing also takes place if risk of default increases with the size of loan or if there is a moral-hazard problem. Limited liability may increase the riskiness of the project financed by the FFIs. In some cases, FFIs may find it possible to specify all relevant characteristics of the investment project as part of the loan contract and enforce such agreements by monitoring the borrower's behavior. If this cannot be done,

FFIs will want to take into account the effect that the terms of the loan have on the borrower's project choice. A change in interest rates affects project choice in the same way that a change in coverage influences a policyholder's level of care in avoiding accident. This moral hazard may perform essentially the same role as interest-rate ceilings in inducing non-price credit rationing.

Moral hazard is only one example of a broader class of imperfections that prevail in credit markets. Another type of market imperfection arises when the outcome of the investment project depends both on some state of nature to be realized at a later date and on the amount of additional resources that the borrower is willing to contribute to the project after that state is realized, but before the loan becomes due. Since the borrower receives only that part of the outcome that remains after repaying the loan, he or she will either contribute the same amount of new resources as if the entire outcome were received and repay the loan in full or will contribute no new resources and default. Since the borrower will choose the latter course whenever the amount left over after paying back the loan should be less than the opportunity cost of the new resources, an increase in the interest rate will increase the likelihood of default.

According to Fried and Howitt (1980), credit rationing exists as part of an equilibrium risk-sharing arrangement

between the FFIs and the borrowers. Borrowers and lenders can benefit not only from trading loan contracts now but also from an understanding, or implicit contract, concerning the amounts they will be willing to trade, and at what prices, under various conditions in the future. This is the old "customer relationship." By means of such arrangements, borrowers and FFIs can share the risks associated with an uncertain future. By dampening the movements in interest rates, these arrangements open up the possibility of nonprice credit rationing.

Most of the imperfections and costs that explain nonprice credit rationing, even in the absence of interest-rate restrictions, exist in the rural credit markets of LICs. Uncertainty, default risks, and transactions, information and collection costs are all particularly high in these fragmented financial markets. Moral hazard and related problems are especially acute. In these markets, FFIs find many reasons to practice one or more forms of nonprice credit rationing.

A Model of Lender Behavior

A simple model of nonprice credit rationing, further discussed in the Appendix of this chapter, is used here to illustrate the differential impact of interest-rate ceilings on access to credit by different borrower classes and on portfolio concentration. I assume that the lender is a profit-maximizing firm (this assumption is further justified

in the discussion that follows) and that the lender's only source of revenue is the interest payments on loans. There are three components of the firm's lending costs: the opportunity cost of the funds, the costs of administration of the loans, and the losses due to default.

The opportunity cost of the funds is exogenously given to the lender, independently of loan size, and is identical for all borrower classes. The costs of administration, in turn, include the handling costs of the loan and the risk-reducing costs of the loan. Handling costs are incurred in recording and disbursing the loan and in receiving payments. These costs tend to be independent of the size and degree of riskiness of the loan. Thus, average handling costs decline with loan size.

Risk-reducing costs are directed at lowering the probability of default in the loan portfolio through the use of information in borrower selection and through collection efforts. These costs are not independent of loan size or of the expected losses due to default. If more resources are spent in loan evaluation and supervision, the lender can reduce losses. The lender cannot, however, completely eliminate uncertainty about repayment. Therefore, it must always include, among its ex ante costs, a premium for risk.

FFIs do not know, ex ante, if a particular borrower will repay a loan. Instead, they must estimate the probable losses due to default. This probability of default, and the

corresponding premium for risk, depend on the borrower's ability and willingness to repay. This is a function of the outcome of the productive activity financed with the loan and of the value of the additional collateral offered.

In order to determine the probable losses due to default, FFIs usually distinguish among several borrower classes and estimate that a certain proportion of the borrowers in a given class will default. In addition, FFIs estimate the expected losses related to this default. It is in the interest of FFIs to distinguish among as many borrower classes as possible. However, this requires information that is costly to acquire and process, so instead FFIs set up a small number of borrower classes and estimate cost functions, including an ex ante premium for risk, for each class. Because of the nature of their productive activities and of the collateral offered, loans to borrowers in certain classes are riskier than loans to other borrowers. Therefore, although FFIs will charge the same premium for risk for a loan of a given size within a given borrower class, they will want to charge a different premium to borrowers in different classes.

Even though additional information reduces the required premium for risk, it also increases administration costs. In order to estimate their cost functions, FFIs must determine the optimum (least-cost) combination of information

costs and the residual risk accepted. The sum of the premium for risk and the risk-reducing administration costs will be minimized when the marginal cost of additional information is equated to the marginal return of using additional information to reduce default losses.

Interest-rate restrictions and other financial regulations usually tend to restrict the use of information by FFIs. If FFIs operate with narrow margins, the evaluation of mortgageable property may be the only risk-reducing activity they can afford. As a result, the allocation of loans will be strongly influenced by the type of security offered. Under these conditions small farmers with few assets to offer will be penalized.

The costs of, and returns to, the use of information in borrower selection are a function of the degree of homogeneity among borrowers. Homogeneity makes it possible to have few borrower classes. Given the heterogeneity found among small farmers in LICs, however, FFIs ought to establish a relatively large number of classes. But interest-rate ceilings restrict the number of borrower classes that FFIs can serve. As a result of these ceilings, many small producers and new potential borrowers are thrown into the class of nonborrowers, because FFIs cannot afford the information costs involved in classifying them in one of the established classes. Since the risk premium for this residual class of potential borrowers is too high, compared

to the interest-rate ceilings, these producers are excluded from the portfolios of the FFIs.

For a given borrower class, the premium for risk increases with loan size, as long as the project financed is of a fixed size; the project financed, even of variable size, shows diminishing marginal returns; the variance of marginal returns increases with loan size; or the value of the collateral offered does not increase as rapidly as loan size. Given diminishing marginal returns to the use of information, this implies that the (optimal) sum of risk-reducing costs and premium for risk increases with loan size. As a result, the marginal costs of lending are an increasing function of loan size.

As mentioned earlier, loan contracts have many dimensions. Thus, loans are viewed as nonhomogeneous products by lenders. In particular, loans to different classes of borrowers are treated as different products if the lender distinguishes among the classes and estimates different cost functions for each borrower class. It is appropriate, therefore, to use the theory of the multiproduct firm to examine lender behavior.

This is done in the model presented in the Appendix, which shows that, when the lender can behave as a perfectly discriminating monopolist, it will charge different interest rates to different borrowers, reflecting the different elasticities of demands for credit as well as the different

marginal costs of lending to alternative borrower classes. If, on the other hand, loan rates are constrained, profit maximization may require nonprice credit rationing. In effect, if the constrained loan rate is higher than the marginal cost of lending for the size of loan demanded, the borrower will not be rationed, but if the constrained rate is lower than marginal cost, the lender will limit the size of the loan granted. A larger loan would simply imply an addition to costs higher than the addition to revenues and a reduction in expected profits. Depending, therefore, on the relative level of the ceilings, with respect to the various marginal cost of lending curves, some or all of the borrower classes may be subject to nonprice rationing, and some borrowers will receive loans smaller than those demanded.

The Iron Law of Interest-Rate Restrictions

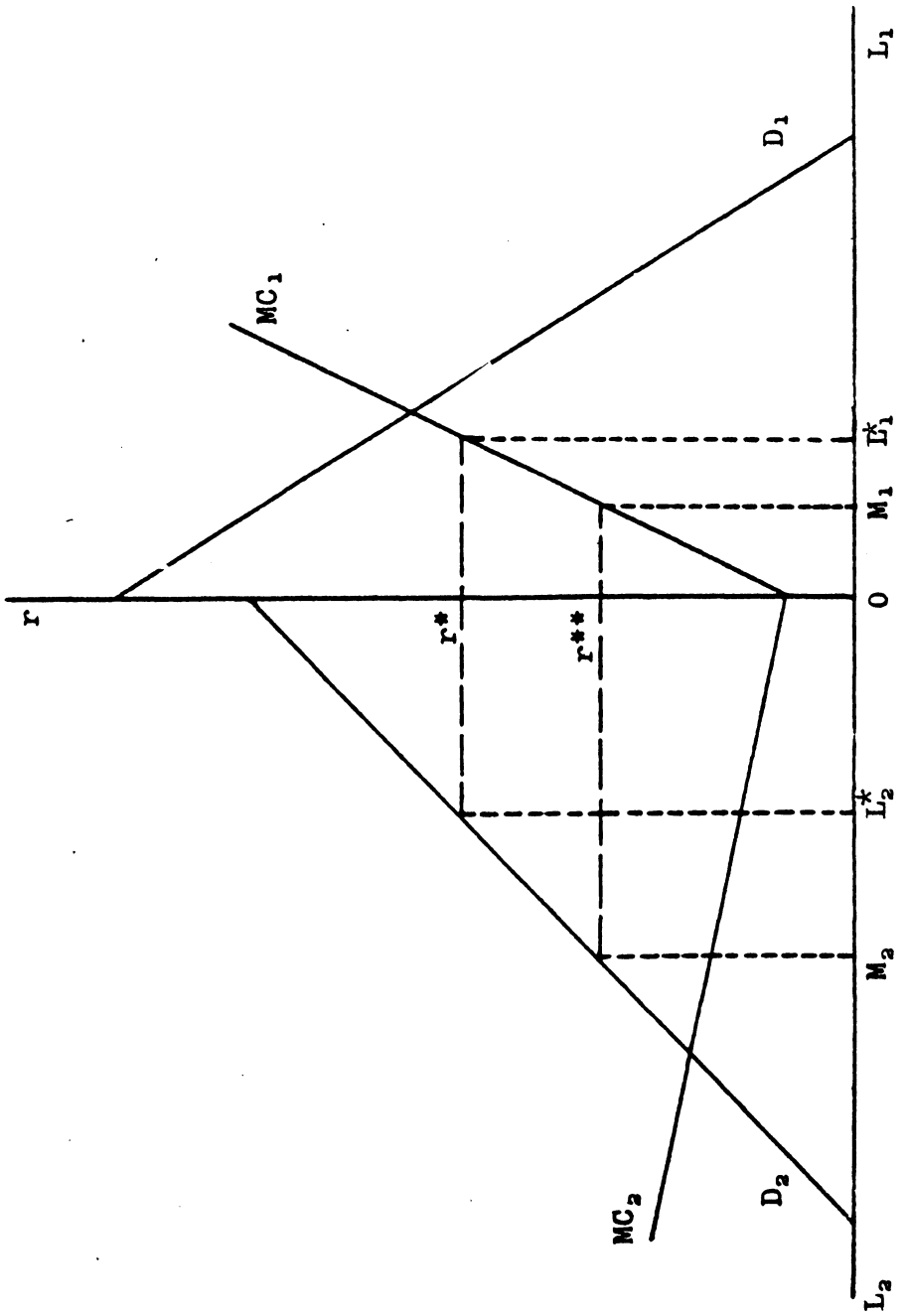
Nonprice credit rationing is widely practiced by FFIs in LICs, and the lenders employ many devices to restrict the size of the loans granted to certain borrower classes. One of the most popular mechanisms for rationing credit is to specify, for each crop, the maximum amount that can be granted per unit of land cultivated. Frequently, the proportion of total costs represented by these amounts varies significantly from crop to crop. These differences tend to reflect the perceptions of FFIs about the risks and costs associated with loans for the production of different crops. Usually the proportion financed is higher for the safer,

more profitable export crops than for the small-farmer subsistence crops. The setting of these limits has also been vulnerable to pressures from growers associations, particularly in the case of public FFIs and at times when the implicit interest-rate subsidy has been substantial. Rationed borrowers are thus forced to complement the loans received from the FFIs with loans obtained in informal credit markets, at higher interest rates. The extent of this additional financing reflects the extent of excess demand for credit from the FFIs.

In LICs, the loan portfolios of FFIs usually include both rationed and nonrationed classes of borrowers. When interest-rate ceilings become more restrictive, the size of the loans granted to the nonrationed borrower classes increases, while the size of the loans granted to the rationed borrower classes diminishes. This is the Iron Law of Interest Rate Restrictions.

A two-borrower case is shown in Figure 1. Positive loan amounts, L_1 and L_2, are measured in both directions from the origin, 0. Demand for credit curves for each borrower, D_1 and D_2, are inversely related to the real rate of interest charged, r. The lender's marginal cost curves, MC_1 and MC_2, increase with loan size. At a given interest-rate ceiling, r^*, the rationed borrower (represented in the right-hand quadrant) receives a loan of size L_1^*, which equates the interest rate charged with the marginal cost of lending and leaves the borrower with an unsatisfied demand

FIGURE 1



for credit. The nonrationed borrower, represented in the left-hand quadrant, receives the size of loan demanded, L_2^*. As the interest-rate ceiling is lowered from r^* to r^{**}, the size of the loan granted to the nonrationed borrower increases, from L_2^* to M_2, as he or she demands a larger loan. At the same time, the size of the loan granted to the rationed borrower declines, from L_1^* to M_1 (movement along the lender's marginal cost curve, not along the borrower's demand curve).

The changes in loan size implied by the Iron Law of Interest Rate Restrictions cause a redistribution of the loan portfolios of the FFIs, as the nonrationed borrowers get larger shares of these portfolios and the rationed borrowers get smaller shares. Finally, when the interest-rate ceiling becomes very low, some borrower classes are excluded altogether from formal loans. A large proportion of the rural producers in LICs are in these excluded groups.

Since the nonrationed borrowers tend to be the large, wealthy, and influential producers, who are already receiving the largest loans, the behavior of the FFIs implied by the Iron Law of Interest Rate Restrictions leads to a further concentration of the size distribution of their loans. This process of increasing concentration is accelerated by the exclusion of potential borrower classes from the credit portfolios, as the FFIs are precluded from covering their average variable costs of lending in these

cases. This progressive concentration of loan portfolios and the exclusion of marginal producers from access to institutional credit significantly worsens the distribution of wealth.

High transaction costs for both lenders and borrowers limit the size of rural financial markets in LICs. When ceilings are imposed on interest rates, FFIs may be unable to cover these costs. Because of this, they will practice nonprice credit rationing and manipulate the noninterest terms of the loan contracts. The stricter terms of the contract shift some transaction costs from the FFIs to the borrowers, but this shift does not affect all classes of borrowers uniformly. Rather, it tends to restrict the access of marginal borrowers to institutional credit more than proportionately, in the fashion of the Iron Law of Interest Rate Restrictions, and further contributes to a higher concentration of loan portfolios.

Rationing and the Lender's Objective Function

The models of lender behavior presented in this chapter are based on the assumption of profit maximization as the lender's objective. This assumption, however, is not necessary, and the results obtained <u>are not</u> dependent on it. The composition of the credit portfolios of FFIs is not a random or unconscious result; it is the consequence of lenders' attempts to optimize a given objective function within the constraints they face. That is, FFIs can be

treated as rational optimizers that possess an explicitly or implicitly defined objective function and attempt to get the optimum result from their operations.

Different types of FFIs, of course, have different objective functions. Some of them are small private banks maximizing profits, whereas others are large banks attempting to maximize market shares; some of them are public development banks attempting to maximize their political influence, and others are public or private institutions maximizing staff expenditures, managerial emoluments, or discretionary profits under different sets of constraints. Given these constraints, all of them are attempting to maximize some utility function, in terms of their managers' set of preferences, through the pursuit of either profit maximizing or nonprofit maximizing strategies or of some combination of both. Although the actual impact of interest rate restrictions on the behavior of FFIs depends on the nature of their particular objective functions, some general considerations can be made.

For our purposes, FFIs can be grouped into two classes: those with an objective function that includes financial viability and institutional survival among the goals pursued and those with an objective function that does not include financial viability. This second group of lenders includes pilot projects not interested in a permanent presence as a lender in the rural areas. It also includes agencies set up

to temporarily disburse relief loans. The first group includes all FFIs that, independently of the kinds of goals they are attempting to achieve, operate under the constraint that they must remain financially viable.

For FFIs to remain financially viable they must be able to preserve, and possibly increase, their loan portfolio in real terms. That is, they must maintain the purchasing power of their assets. To do this, their revenues must cover a significant portion, if not all, of their lending costs. To remain financially viable, therefore, FFIs must take into account revenues and costs; that is, they must have a profits strategy. As was pointed out by Bourne and Graham (1984), if they do not, they will not survive.

In order to survive and maintain their relative importance within the financial sector, FFIs must preserve the purchasing power of the claims on resources they mobilize. Otherwise, they will be less able to serve their clients, their market shares will decline, and the political support that they need for their survival will diminish. FFIs are able to preserve the real size of their portfolios to the extent that they protect them from the eroding impact of inflation, to the extent that they collect the loans granted, and to the extent that they are able to generate sufficiently high profits.

Consider, for example, two identical FFIs, each one supplying 50 percent of the local credit market. One of

them generates profits of 2 percent per year; while the other generates annual profits of 12 percent. After 10 years, ceteris paribus, the more profitable institution will be serving 72 percent of this credit market, whereas the less profitable one will be serving only 28 percent.

Some FFIs may have continued access to the government budget, central bank rediscounting, or cheap credit from international agencies, that allows them to remain temporarily viable, despite their losses. However, some measure of profitability is always included in evaluations of the performance of FFIs. International agencies and fiscal sources are usually only willing to continue with their support as long as the FFIs' losses are modest and temporary. International agencies are also judged by the success and financial strength of the FFIs they support. If FFIs' losses are high, international agencies will demand a management change or will request institutional reforms and program reorientations before they continue with their support. When the losses of FFIs are large, fiscal sources may not possess sufficient resources to continually provide the transfers needed. This is especially true of governments in LICs that are facing severe budgetary problems. Although inflationary financing from the central bank could make transfers in nominal terms possible, the ensuing inflation would erode the real value of the portfolio of the FFIs even faster.

Moreover, FFIs that receive large fiscal transfers lose their independence and are forced to accept political guidance in credit allocation. When banking and economic criteria are replaced by administrative and political decisions, the credit-rationing process becomes more vulnerable to pressures from specific borrower groups, and loan portfolios become more concentrated. Also, the reluctance of politicians to take into account creditworthiness and to enforce vigorous collection policies leads to high rates of default. These FFIs become costly and arbitrary mechanisms for political income transfers to relatively few borrowers and, unless huge fiscal transfers are forthcoming, do not long survive.

Conclusions

In most LICs, the interest rates charged by FFIs on agricultural loans have been administratively set or are constrained by regulations. As a result, these rates have been too rigid in nominal terms and too erratic and unpredictable in real terms; too low, from several perspectives; and too differentiated. FFIs have been forced to charge the lowest rates where they would have liked to charge the highest rates. This inverted structure of interest rates has accentuated the differential impact of the costs of lending on the relative profitability of loans to different borrower classes and has distorted the allocation of the loan portfolios of the FFIs among borrower classes.

The conventional model, on the basis of an aggregate demand and supply of credit, cannot explain the distributive consequences of interest rate restrictions. This chapter has explored models of nonprice credit rationing and of rationing through the noninterest terms of the loan contracts, to show how interest rate ceilings restrict the access of small farmers to institutional credit, and how this results in a high degree of concentration of the loan portfolios of the FFIs.

In particular, the chapter has shown that, according to the Iron Law of Interest Rate Restrictions, as interest-rate ceilings become more restrictive, the size of the loans granted to nonrationed large producers increases, while the size of loans granted to rationed small producers decreases. This behavior of lenders leads to a redistribution of loan portfolios in favor of the larger borrowers. Through these mechanisms, therefore, the interest-rate ceilings enforced in most of the LICs have been an important determinant of the limited access to institutional credit and the high degree of concentration of loan portfolios that characterize rural financial markets.

Appendix on Profit-Maximizing Rationing

With respect to a given borrower class, the lender's costs, as a function of loan size, have been defined as

(1) $C = dL + H + xL$

where: C: total cost of the loan,

d: constant average opportunity cost of the funds,

L: loan size,

H: fixed handling costs of the loan, and

x: optimum sum of average risk-reducing costs and the premium for risk.

In turn, the lender's profit function can be defined as

(2) $\pi = \sum^{n} R_i - \sum^{n} C_i$

where: $R_i = r_i L_i$,

π : the lender's total profits,

R_i : revenues from a loan to the i^{th} borrower (or class),

r_i : the interest rate charged to the i^{th} borrower (or class),

L_i : the size of the loan granted to the i^{th} borrower (or class), and

C_i : the total cost of the loan granted to the i^{th} borrower (or class).

If the lender is a perfectly discriminating monopolist, it will charge different interest rates for a loan of the same size to borrowers of different classes, as well as different interest rates for loans of different sizes within a given borrower class. In this case, the first order conditions for profit maximization are

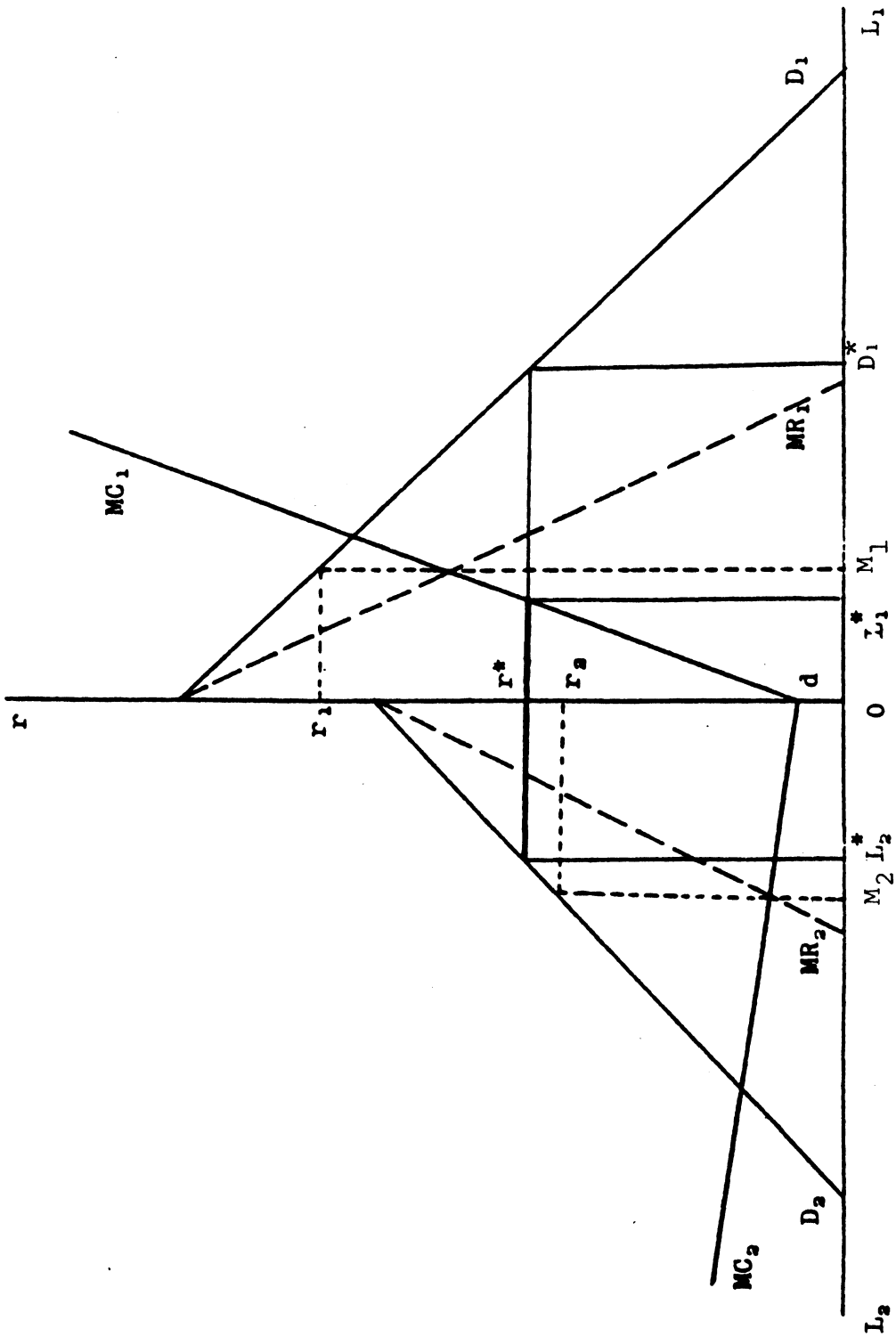
$$(3) \quad \frac{\partial \pi}{\partial L_i} = \frac{\partial R_i}{\partial L_i} - \frac{\partial C_i}{\partial L_i} = 0.$$

That is, profit maximization requires that the marginal revenue and the marginal cost of the loan be equated for the size of loan granted to each particular borrower. In these circumstances, the rates of interest charged to different borrowers will differ, reflecting both the different elasticities of the demand for credit from different borrowers and the different marginal costs of lending to them. Obviously, nonprice rationing will not occur in this case. This situation is represented for a two-borrower case in Figure 2.

In Figure 2, positive loan amounts (L_1 and L_2) are measured in both directions from the origin, 0. The demand functions for each borrower (D_1 and D_2) are inversely related to the real rate of interest charged, r. Marginal revenue functions for the lender (MR_1 and MR_2) are associated with the demand functions. The lender's marginal cost functions (MC_1 and MC_2) increase with the size of loan. Profit maximization requires that marginal revenue be equated to marginal cost for each borrower. Thus, the lender must grant loans of size M_1 and M_2 and charge different interest rates, r_1 and r_2, to the two borrowers.

The simplest restriction that can be imposed on the rates of interest charged by FFIs is the requirement that they charge a uniform interest rate to all borrowers. It is assumed that FFIs are free to set this uniform rate at their most profitable level. The model can be used to show that in this case profit maximization may require nonprice credit rationing.

FIGURE 2



Given the possibility of rationing (that is, the existence of individual excess demands for credit at the uniform interest rate charged by the lender), the profit-maximizing loan sizes for different borrowers can be obtained. This can be done, following Eckaus (1974), through the solution of a programming problem in which the demand functions are introduced as inequality constraints. If there is no rationing, loan size will equal the amount of credit demanded at the uniform rate charged. If there is rationing, the inequality constraint will be binding, and an excess demand for credit will exist. The programming problem consists of maximizing lender's profits, given the uniform rate charged and the size of the loans granted to different borrowers, subject to the constraints that the rate charged be the same for all borrowers and that the size of each loan be equal to or less than the amount demanded at the profit-maximizing rate.

The lender's total profits can be defined as

$$(4) \qquad \pi = r \sum_{}^{n} L_i - \sum_{}^{n} C_i$$

Total profits must be maximized, subject to

$$(5) \qquad L_i - D_i \leq 0$$

$$r \geq 0$$

$$L_i \geq 0$$

The corresponding Lagrangian function K is

$$(6) \qquad K = r \sum_{}^{n} L_i - \sum_{}^{n} C_i - \sum_{}^{n} \lambda_i (L_i - D_i)$$

The Kuhn-Tucker conditions for maximum profits are

$$(7) \qquad \frac{\partial K}{\partial r} = \sum_{}^{n} L_i + \sum_{}^{n} \lambda_i \frac{\partial D_i}{\partial r} \leq 0$$

$$\frac{\partial K}{\partial L_i} = r - \frac{\partial C_i}{\partial L_i} - \lambda_i \leq 0$$

$$r \sum^{n} [L_i + \lambda_i \frac{\partial D_i}{\partial r}] + \sum^{n} L_i [r - \frac{\partial C_i}{\partial_i L} - \lambda_i] = 0$$

$$L_i - D_i \leq 0$$

$$\lambda_i (L_i - D_i) \leq 0$$

$$\sum^{n} \lambda_i (L_i - D_i) = 0$$

$$\lambda_i \leq 0$$

$$L_i \geq 0$$

$$r \geq 0$$

These conditions imply that when credit rationing does not take place, the Lagrangian multiplier must be strictly positive. That is, if a borrower receives the size of the loan demanded, $L_i = D_i$ and $\lambda_i > 0$. On the other hand, credit rationing occurs when $L_i - D_i < 0$. In this case, the Lagrangian multiplier must be equal to zero; i.e., $\lambda_i = 0$. Therefore, when in the programming exercise one of the Lagrangian multipliers becomes equal to zero, the corresponding borrower (or class) is rationed.

The Kuhn-Tucker conditions imply that, for the Lagrangian multipliers to become equal to zero and for rationing to occur, the rate of interest charged has to become equal to the marginal cost of granting the loan. If there is no rationing, the rate of interest charged has to be higher than the corresponding marginal cost.

Therefore, when a uniform but free interest rate is enforced, if the profit maximizing rate is less than the marginal

cost of lending to a particular borrower, the lender will limit the size of the loan granted and an excess demand for credit ($D_i^* - L_i^*$) will prevail at the rate charged. If, in these circumstances, the lender granted a larger loan, as demanded, the addition to its costs would be higher than the addition to its revenues, and its expected profits would decline. The optimum uniform rate must be bounded by the rates that a discriminating monopolist would charge to the various borrowers, so that at least one class of borrowers will not be rationed.

As indicated earlier, Figure 2 shows a two-borrower situation where M_1 and M_2 are the profit-maximizing size of loans granted by an unconstrained discriminating monopolist, while r_1 and r_2 are the interest rates charged. The profit-maximizing interest rate set by a lender forced to charge a uniform rate to all borrowers is r*, while L_1^* and L_2^* are the size of loans granted in this case. Given the levels of the marginal cost curves and of the uniform interest rate, one borrower is not rationed while the other one is ($L_1^* < D_1^*$), where D_1^* is the size of loan demanded at r*.

Nonprice credit rationing will be practiced, *a fortiori*, when a binding ceiling on interest rates is enforced. Assume that a ceiling r^* is imposed on the rates of interest charged on all kinds of loans. In this case, the lender's profit function will be

$$(8) \qquad \pi = r^* \sum^{n} L_i - \sum^{n} C_i$$

This function has to be maximized subject to

$$(9) \qquad L_i - D_i \leq 0$$

$$L_i \geq 0$$

$$0 \leq r^* < r_i;$$

that is, the ceiling is binding for all borrowers. The corresponding Lagrangian function is

$$(10) \qquad K = r^* \sum^{n} L_i - \sum^{n} C_i - \sum^{n} \lambda_i (L_i - D_i)$$

The Kuhn-Tucker conditions for maximum profits are

$$(11) \qquad \frac{\partial K}{\partial L_i} = r^* - \frac{\partial C_i}{\partial L_i} - \lambda_i \leq 0$$

$$\sum^{n} (r^* - \frac{\partial C_i}{\partial L_i} - \lambda_i) L_i = 0$$

$$\lambda_i (L_i - D_i) \leq 0$$

$$L_i - D_i \leq 0$$

$$L_i \geq 0$$

$$\lambda_i \leq 0$$

Again, these conditions imply that, in the absence of rationing, the Lagrangian multipliers will be strictly positive. This implies that marginal cost is lower than the given interest-rate ceiling. On the other hand, rationing implies that $\lambda_i = 0$. Thus, when rationing is taking place, the marginal cost of the loan is being equated to the ceiling interest rate. Depending on the relative level of the ceiling, with respect to the marginal cost curves of lending, some or all of the borrowers may be subjected to nonprice credit rationing.

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